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(71) Applicant: LUCENT TECHNOLOGIES INC.  
Murray Hill, New Jersey 07974-0636 (US)

(72) Inventors:  
• Demetrescu, Christian  
Twickenham, Middlesex TW2 5LY (GB)  
• Ilas, Constantin  
Swindon, Wiltshire SN5 7BB (GB)

- Samaras, Kostas  
Swindon, Wiltshire SN2 2HL (GB)
- Samuel, Louis Gwyn  
Swindon, Wiltshire SN2 3YG (GB)
- Somerville, Fiona Clare  
Millbrook Place, Bath BA2 4JY (GB)
- Wu, Jian Jun  
Reading, Berkshire (GB)
- Yan, Ran-Hong  
Faringdon, Oxfordshire SN7 7SS (GB)

(74) Representative:  
Buckley, Christopher Simon Thirsk et al  
Lucent Technologies Inc.,  
5 Morningside Road  
Woodford Green, Essex IG8 0TU (GB)

## (54) Multi-polling system for GPRS

(57) A mobile telephone network operating general packet radio service includes a base station (2) and a group of mobile telephones (M1 to M4).

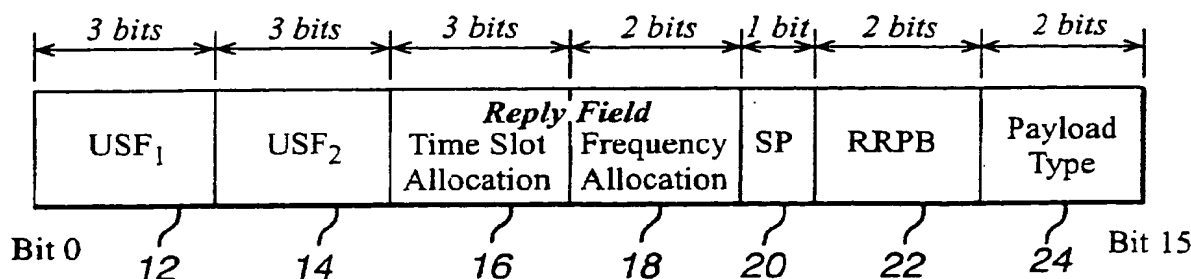
The base station (2) includes a control unit (8) which generates a succession of data packets which are transmitted along a common downlink to all the mobiles (M1 to M8).

Each data packet includes a header section containing an uplink state flag identifying a first selected mobile, to poll that mobile and cause it to return a packet of data to the base station along a common uplink channel. The header also includes an uplink state flag iden-

tifying a second selected mobile and is accompanied by the identity of and time slot for a second auxiliary uplink channel for polling the second mobile to cause the second mobile to return a packet of data to the base station along said auxiliary uplink channel thereby enabling the polling of at least two mobiles using the same data packet.

The polling sequence produced by the control unit (8) ensures that each mobile is polled twice during each polling cycle, once accompanied with the identity of and time slot for a secondary auxiliary uplink channel and once without.

FIG. 2



## Description

### Field of the Invention

**[0001]** The present invention relates to data transmission systems, and in particular to mobile telephone networks employing such systems, and to base stations and satellite stations for use in such systems.

### Background of the Invention

**[0002]** In a mobile telephone network, there are a plurality of base stations serving different areas. Each base station is arranged to communicate with a plurality of mobile telephones in an associated area.

**[0003]** The base station communicates with the mobile telephones using a discrete number of channel frequencies. The mobile telephones are typically arranged in groups with the base station sending signals to all the members of the group along a common downlink channel having one unique frequency allocated to that group. The base station receives signals from each of the mobile telephones in the group along an uplink channel having a different unique frequency allocated to that group.

**[0004]** In operation, the base station sends data to all the mobile telephones of each group in a succession of data packets along the common downlink channel. Each packet of data consists of two parts. A first part called a header which contains a code ID identifying a selected mobile of the group and an uplink state flag (USF) for that mobile to trigger that mobile to return a packet of data to the base station and a second part containing a payload of data that the mobile telephone will download and use as required. The header is "transparent", that is it can be read by all the telephones in the group. The payload is cyphered and can only be read and downloaded by the telephone whose ID is contained in the header. The packets are typically of 20ms in duration and, when a particular telephone downloads a packet containing its uplink state flag, that telephone will reply very shortly after receiving the packet by sending a packet of data back to the base station along the common uplink channel.

**[0005]** If each mobile telephone only receives one uplink state flag (ie is polled) during each cycle of successive packets of data transmitted by the base station, it can only send data to the base station during one 20ms period in every cycle.

**[0006]** It is an object of the invention to provide an improved polling efficiency.

### Summary of the Invention

**[0007]** According to one aspect of this invention there is provided a data transmission system comprising a base station having a radio transmitter and a receiver and a plurality of satellite stations each having a radio

transmitter and a receiver, the transmitter of the base station and the receivers of the satellite stations all being tuned to the same downlink channel, and the transmitters of the satellites and the receiver of the base station all being tuned to a common uplink channel and at least one auxiliary uplink channel, the base station including control means for cyclically generating a succession of data packets and transmitting them to the satellites, each data packet comprising a header section having a first section, containing a first uplink state flag identifying with a first selected satellite which when received by the first selected satellite polls that satellite alone to cause it to send a data packet back to the base station along the uplink channel, and a second section containing second uplink state flag identifying a second selected satellite coupled with the identity of and time slot for, a said auxiliary uplink channel which when received by the second selected satellite polls that satellite alone to cause the said second selected satellite to send a data packet back to the base station along said auxiliary uplink channel in said time slot, the number of packets in each cycle corresponding to the number of said plurality of satellite stations, an uplink state flag for each satellite appearing once in a said first section of a said header during each cycle and appearing once in a said second section of a different header during the same cycle whereby each satellite is polled twice during each cycle once in response to an uplink state flag in a first section of a header and once in response to an uplink state flag in a second section of a different header.

**[0008]** According to another aspect of this invention there is provided a base station having a radio transmitter and a receiver for communication with a plurality of satellite stations, the transmitter of the base station being tuned to a predetermined downlink channel, and the receiver of the base station being tuned to a predetermined uplink channel and at least one auxiliary uplink channel, the base station including control means for cyclically generating a succession of data packets for transmission to the satellite stations, each data packet comprising a header section having a first section, containing a first uplink state flag identifying with a first selected satellite station, and a second section containing second uplink state flag identifying a second selected satellite station coupled with the identity of and time slot for said auxiliary uplink channel, the number of packets in each cycle corresponding to the number of said plurality of satellite stations, an uplink state flag for each satellite station appearing once in a said first section of a said header during each cycle and appearing once in a said second section of a different header during the same cycle whereby the base station polls each satellite station twice during each cycle, once in response to an uplink state flag in a first section of a header and once in response to an uplink state flag in a second section of a different header.

**[0009]** According to a further aspect of this invention there is provided a satellite station with a unique identity

having control means and a radio transmitter and a receiver for communicating with a base station, the receiver of the satellite station being tuned to a predetermined downlink channel, and the transmitter of the satellite station being tuned to a predetermined uplink channel and at least one auxiliary uplink channel, the satellite station being arranged to receive from said base station a succession of data packets, each data packet comprising a header section having a first section, containing a first uplink state flag carrying the identity of a first selected satellite station which if that identity corresponds with the said unique identity causes the control means to send via the transmitter a data packet via the transmitter back to the base station along said uplink channel, and a second section containing second uplink state flag carrying the identity of a second selected satellite station coupled with the identity of and time slot for, a said auxiliary uplink channel, which if that identity corresponds to said unique identity causes the control means to send a data packet back to the base station along said auxiliary uplink channel in said time slot, an uplink state flag carrying said unique identity appearing once in a said first section of a said header during each cycle and appearing once in a said second section of a different header during the same cycle whereby said satellite station transmits data back to the base station twice during each cycle.

#### Brief Description of the Drawings

[0010] A mobile telephone network embodying the present invention, will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a block diagram of a base station communicating with a plurality of mobile telephones;  
Figure 2 is a diagram illustrating the composition of the header of a data packet;  
Figure 3 is a polling table illustrating the order of polling where there are three mobiles in each group; and

Figure 4 is a polling table illustrating the order of polling where there are four mobiles in each group.

#### Description of the Preferred Embodiment

[0011] As shown in Figure 1, a base station 2 includes a radio transmitter 4 and receiver 6 for transmitting data simultaneously to a group of four satellites or mobile telephones M1 to M4 along a downlink channel of frequency  $f_2$  and for receiving data principally along an uplink channel of frequency  $f_1$ .

[0012] The signals generated by a control unit 8 and transmitted by the base station 2 consist of a series of packets of a data each of 20ms duration.

[0013] As shown in Figure 2, each data packet includes a fixed length header H. The header includes a

primary uplink state flag slot 12 containing, for example, the uplink state flag  $USF_1$  for mobile M1 and a secondary uplink state flag slot 14 containing, for example, the uplink state flag  $USF_2$  for the mobile M2. The secondary uplink state flag slot is followed by a time slot 16 and a frequency slot 18 defining, for example, a time slot T3 in an auxiliary uplink channel of frequency  $f_3$ . The payload P then follows. Then in order to permit compatibility with current GPRS MAC (General Packet Radio Service Medium Access Control) standards, three additional slots, 20, 22, 24, respectively for Supplementary Polling (SP) data, Relative Reserve Block Period (RRBP) data and payload data are provided. All this data is associated with the mobile identified by  $USF_1$ , slot 2.

[0014] In operation, when the mobile telephone M1 receives the packet, it responds to the uplink state flag  $USF_1$  to transmit a packet of data along the default uplink channel of frequency  $f_1$ . When the mobile telephone M2 receives the same packet of data, it responds to the uplink state flag  $USF_2$  to transmit a packet of data in a specific time slot  $TS_3$  along the auxiliary uplink channel of frequency  $f_3$ .

[0015] In this way, the base station can receive two data packets from two mobile telephones in response to the same packet of data sent along the downlink channel.

[0016] While the auxiliary uplink channel has been defined as having a frequency of  $f_3$ , it will be appreciated, that the base station may have a number of other channels of different frequency available for use as an auxiliary uplink channel. The base station may therefore select different auxiliary uplink channels on different occasions according to availability.

[0017] The modified MAC header shown in Figure 2 is two bytes in length ie 8 bits longer than the standard MAC header. Of these 8 bits, three are taken up by  $USF_2$ , the uplink state flag of the speculatively polled mobile M2 and five are taken up by the reply field consisting of time slot allocated subfield 16 three bits in length and a frequency allocation subfield 18 two bits in length.

[0018] The impact of the additional length in the header can be absorbed by removing more of the redundancies from the Vo GPRS (Voice GPRS) coder. An alternative would be to adopt a different lower bit rate voice coder.

[0019] In order to achieve efficient polling, it is important to create the correct polling pattern. Since the mobile polled in slot 12 always has a dedicated uplink (UL) reply channel, it is important that all the mobiles in any group are polled having their uplink state flag opening in slot 12 of a header once in every polling cycle. Also during each polling cycle, the uplink state flag of each mobile should appear in the slot 14 of a header.

[0020] Thus, with a group of three mobiles, the control unit 8 will generate three packets for each cycle. The slot 12 of the header in the first packet and the slot 14

in the header of the third packet will contain the USF<sub>1</sub> for mobile M1. The slot 14 of the header in the first packet of the slot 12 of the header in the second packet will contain the USF<sub>2</sub> for mobile M2. The slot 14 of the header in the second packet and the slot 12 of the header in the third packet will contain the USF<sub>3</sub> for the mobile M3. The cycle is then repeated ad infinitum.

**[0021]** The polling pattern as illustrated in Figure 3 shows a plurality of groups of three mobiles 1-3, 4-6, 7-9, 10-12 and 13 to 15. Each group has a different uplink channel and Time Slot (TS) for the auxiliary channel. Each packet is 20ms long with each cycle being repeated once every 60ms. From Figure 3, it will be seen that the notation 1/2 in the 20ms column represents the USF of mobile M1 in the slot 12 and the USF of the mobile M2 in the slot 14 of the header of the first packet.

**[0022]** Using the polling pattern of Figure 3 has the advantage that if the "speculatively" polled mobile fails the first time around it will be captured the second time around inside the normal polling period. This is especially important for real time traffic since access delays have to be minimised. Using this scheme we can poll three mobiles twice in each 60ms. Therefore, the Polling Group contains three mobiles. The other advantage that this polling scheme has is that it allows the system to send RR (Radio Resource) messaging to the first named and speculatively polled mobiles and indicate the validity of the expected reply (Packet Control Acknowledgement) since the order of the USF within the MAC header is rotated.

**[0023]** If the pattern in Figure 3 is adopted then the subsequent behaviour is as follows. When the mobiles are polled and the polling is successful, ie both mobiles have something to transmit, then the default channel (USF<sub>1</sub>'s paired UL timeslot) and reply channel becomes occupied. If the poll of USF<sub>1</sub> fails then it will be polled again during polling period (40ms-80ms later, depending on the system). If the poll of USF<sub>2</sub> fails then it will be polled again in the following timeslot. The behaviour described in Figure 3 enables an early capture of the USF<sub>2</sub> mobile having data to transmit.

**[0024]** When four mobiles are included in each group, the polling cycle is increased to 80ms. The polling takes place speculatively so that each mobile has an USF appearing at least once in a header slot 12, once every cycle of four packets and a USF appearing at least once in header slot 14, once during the same cycle of packets. Figure 4 shows a table of polling neither of which can be used for different groups of four mobiles.

**[0025]** If the pattern in Figure 4 is adopted then there is no early capturing of data to transmit from the speculatively polled mobile. However, an additional mobile can be added to the Polling Group and the reversal of the ordering of the USFs with the MAC header allows for the scheduling and reply to RR messaging within the MAC header.

## Claims

1. A data transmission system comprising a base station having a radio transmitter and a receiver and a plurality of satellite stations each having a radio transmitter and a receiver. the transmitter of the base station and the receivers of the satellite stations all being tuned to the same downlink channel, and the transmitters of the satellite stations and the receiver of the base station all being tuned to a common uplink channel and at least one auxiliary uplink channel, the base station including control means for cyclically generating a succession of data packets and transmitting them to the satellite stations, each data packet comprising a header section having a first section, containing a first uplink state flag identifying with a first selected satellite station which when received by the first selected satellite station polls that satellite alone to cause it to send a data packet back to the base station along the uplink channel, and a second section containing second uplink state flag identifying a second selected satellite station coupled with the identity of and time slot for, a said auxiliary uplink channel which when received by the second selected satellite station polls that satellite station alone to cause the said second selected satellite station to send a data packet back to the base station along said auxiliary uplink channel in said time slot, the number of packets in each cycle corresponding to the number of said plurality of satellite stations, an uplink state flag for each satellite station appearing once in a said first section of a said header during each cycle and appearing once in a said second section of a different header during the same cycle whereby each satellite station is polled twice during each cycle, once in response to an uplink state flag in a first section of a header and once in response to an uplink state flag in a second section of a different header.
2. A system according to Claim 1, wherein said plurality of satellite stations comprise three in number and are polled twice during each cycle of three packets.
3. A system according to Claim 2, wherein for any two successive packets of data the contents of the second section of the header of the first occurring packet contains the same uplink state flag identity as the first section of the header of the immediately following packet.
4. A system according to Claim 1, wherein said plurality of satellite stations comprise four in number and wherein for any two successive packets of data, the four sections of the two headers are occupied by respective ones of the four uplink state flags associated with the four satellites.

5. A base station having a radio transmitter and a receiver for communication with a plurality of satellite stations, the transmitter of the base station being tuned to a predetermined downlink channel, and the receiver of the base station being tuned to a predetermined uplink channel and at least one auxiliary uplink channel, the base station including control means for cyclically generating a succession of data packets for transmission to the satellite stations, each data packet comprising a header section having a first section, containing a first uplink state flag identifying with a first selected satellite station, and a second section containing second uplink state flag identifying a second selected satellite station coupled with the identity of and time slot for said auxiliary uplink channel, the number of packets in each cycle corresponding to the number of said plurality of satellite stations, an uplink state flag for each satellite station appearing once in a said first section of a said header during each cycle and appearing once in a said second section of a different header during the same cycle whereby the base station polls each satellite station twice during each cycle, once in response to an uplink state flag in a first section of a header and once in response to an uplink state flag in a second section of a different header.  
5  
10  
15  
20  
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6. A base station according to Claim 6, wherein the control means is programmed to poll three satellite stations twice during each cycle of three packets, wherein for any two successive packets of data the contents of the second section of the header of the first-occurring packet contains the same uplink state flag identity as the first section of the header of the immediately following packet.  
30  
35
7. A base station according to Claim 1, wherein the control means is programmed to poll four satellite stations and wherein for any two successive packets of data, the four sections of the two headers are occupied by respective ones of the four uplink state flags associated with the four satellite stations.  
40
8. A satellite station with a unique identity having control means and a radio transmitter and a receiver for communicating with a base station, the receiver of the satellite station being tuned to a predetermined downlink channel, and the transmitter of the satellite station being tuned to a predetermined uplink channel and at least one auxiliary uplink channel, the satellite station being arranged to receive from said base station a succession of data packets, each data packet comprising a header section having a first section, containing a first uplink state flag carrying the identity of a first selected satellite station which if that identity corresponds with the said unique identity causes the control means to send via the transmitter a data packet via the transmitter back to the base station along said uplink channel, and a second section containing second uplink state flag carrying the identity of a second selected satellite station coupled with the identity of and time slot for, a said auxiliary uplink channel, which if that identity corresponds to said unique identity causes the control means to send a data packet back to the base station along said auxiliary uplink channel in said time slot, an uplink state flag carrying said unique identity appearing once in a said first section of a said header during each cycle and appearing once in a said second section of a different header during the same cycle whereby said satellite station transmits data back to the base station twice during each cycle.  
45  
50  
55

FIG. 1

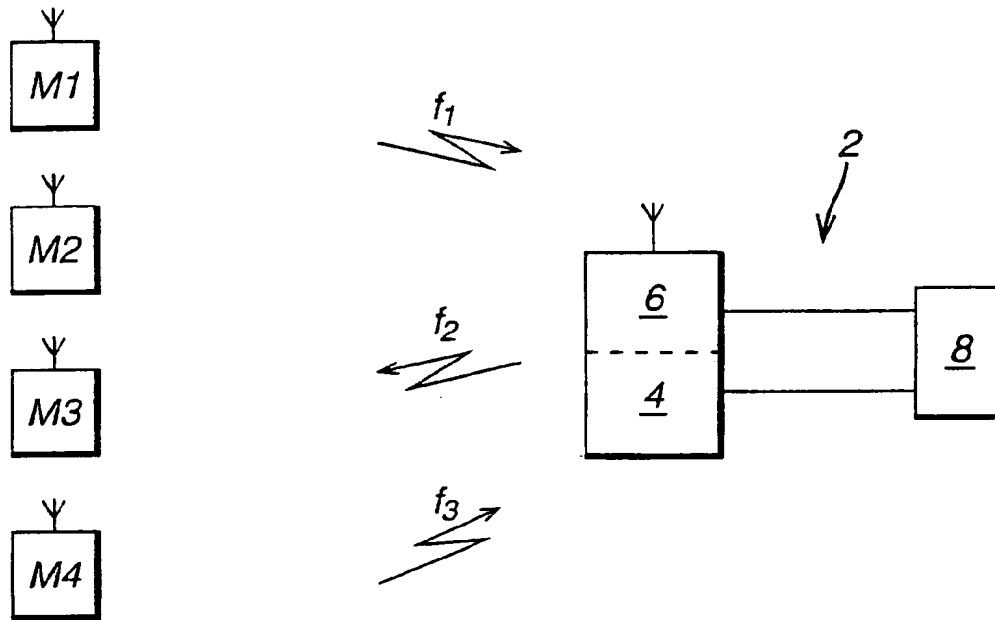
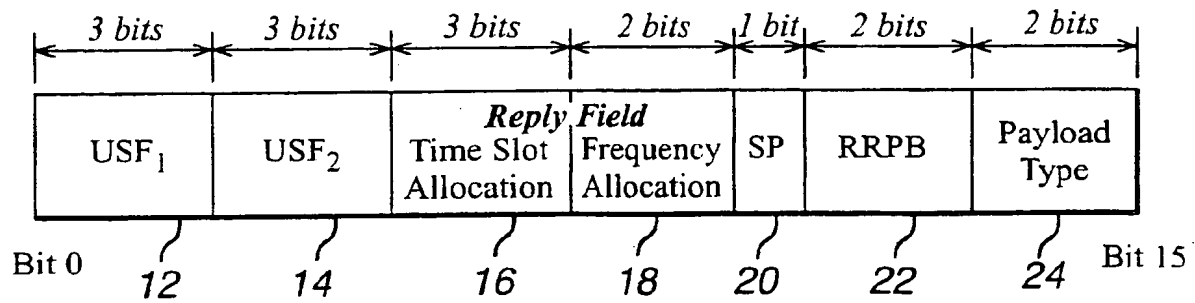


FIG. 2



| <i>Time Slots</i> | <i>Time Line (ms)</i> |       |       |                             |     | <i>Mobiles in Polling Group</i> |
|-------------------|-----------------------|-------|-------|-----------------------------|-----|---------------------------------|
|                   | 20                    | 40    | 60    | 80                          | 100 |                                 |
| TS <sub>1</sub>   | 1/2                   | 2/3   | 3/1   | <i>Sequence Repeats ...</i> |     | 1,2,3                           |
| TS <sub>2</sub>   | 4/5                   | 5/6   | 6/4   | <i>Sequence Repeats ...</i> |     | 4,5,6                           |
| TS <sub>3</sub>   | 7/8                   | 8/9   | 9/7   | <i>Sequence Repeats ...</i> |     | 7,8,9                           |
| TS <sub>4</sub>   | 10/11                 | 11/12 | 12/10 | <i>Sequence Repeats ...</i> |     | 10,11,12                        |
| TS <sub>5</sub>   | 13/14                 | 14/15 | 15/13 | <i>Sequence Repeats ...</i> |     | 13,14,15                        |
| TS <sub>6</sub>   | 16/...                |       |       |                             |     | 16,...                          |
| TS <sub>7</sub>   |                       |       |       |                             |     |                                 |
| TS <sub>8</sub>   |                       |       |       |                             |     |                                 |

FIG. 3

| <i>Time Slots</i> | <i>Time Line (ms)</i> |       |       |       |                | <i>Mobiles in Polling Group</i> |
|-------------------|-----------------------|-------|-------|-------|----------------|---------------------------------|
|                   | 20                    | 40    | 60    | 80    | 100            |                                 |
| TS <sub>1</sub>   | 1/2                   | 3/4   | 2/1   | 4/3   | <i>S.R....</i> | 1,2,3,4                         |
| TS <sub>2</sub>   | 5/6                   | 7/8   | 6/5   | 8/7   |                | 5,6,7,8                         |
| TS <sub>3</sub>   | 9/10                  | 11/12 | 10/9  | 12/11 |                | 9,10,11,12                      |
| TS <sub>4</sub>   | 13/14                 | 15/16 | 14/13 | 16/15 |                | 12,13,14,15                     |
| TS <sub>5</sub>   | 17/...                |       |       |       |                | 17,...                          |
| TS <sub>6</sub>   |                       |       |       |       |                |                                 |
| TS <sub>7</sub>   |                       |       |       |       |                |                                 |
| TS <sub>8</sub>   |                       |       |       |       |                |                                 |

FIG. 4

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(71) Applicant: **LUCENT TECHNOLOGIES INC.**  
**Murray Hill, New Jersey 07974-0636 (US)**

(72) Inventors:  
• **Demetrescu, Christian**  
**Twickenham, Middlesex TW2 5LY (GB)**  
• **Ilas, Constantin**  
**Swindon, Wiltshire SN5 7BB (GB)**

- **Samaras, Kostas**  
**Swindon, Wiltshire SN2 2HL (GB)**
- **Samuel, Louis Gwyn**  
**Swindon, Wiltshire SN2 3YG (GB)**
- **Somerville, Fiona Clare**  
**Millbrook Place, Bath BA2 4JY (GB)**
- **Wu, Jian Jun**  
**Reading, Berkshire (GB)**
- **Yan, Ran-Hong**  
**Faringdon, Oxfordshire SN7 7SS (GB)**

(74) Representative:  
**Buckley, Christopher Simon Thirsk et al**  
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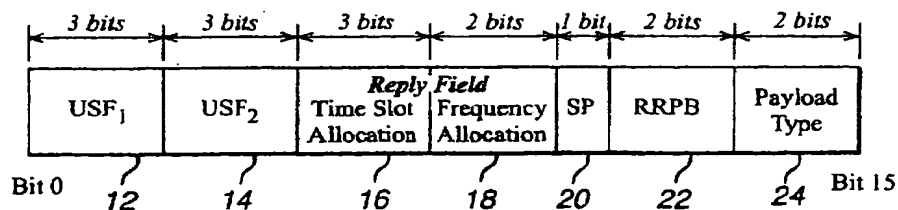
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The base station (2) includes a control unit (8) which generates a succession of data packets which are transmitted along a common downlink to all the mobiles (M1 to M8).

Each data packet includes a header section containing an uplink state flag (USF1) identifying a first selected mobile, to poll that mobile and cause it to return a packet of data to the base station along a common uplink channel. The header also includes an uplink state

flag (USF2) identifying a second selected mobile and is accompanied by the identity of and time slot for a second auxiliary uplink channel for polling the second mobile to cause the second mobile to return a packet of data to the base station along said auxiliary uplink channel thereby enabling the polling of at least two mobiles using the same data packet.

The polling sequence produced by the control unit (8) ensures that each mobile is polled twice during each polling cycle, once accompanied with the identity of and time slot for a secondary auxiliary uplink channel and once without.

**FIG. 2**



European Patent  
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# EUROPEAN SEARCH REPORT

Application Number  
EP 00 30 7839

| DOCUMENTS CONSIDERED TO BE RELEVANT   |   |  |  |
|---|---|--|--|
| Category  | Citation of document with indication, where appropriate, of relevant passages   | Relevant to claim  | CLASSIFICATION OF THE APPLICATION (Int.Cl.7) |
| A   | EP 0 921 662 A (CIT ALCATEL)<br>9 June 1999 (1999-06-09)<br>* column 1, line 52 - column 3, line 53 *   | 1-8  | H04Q7/38<br>H04L12/56                        |
| A   | WO 98 44639 A (NOKIA TELECOMMUNICATIONS OY<br>; MUSTAJAERVI JARI (FI))<br>8 October 1998 (1998-10-08)<br>* page 4, line 9 - line 34; figure 4 * | 1-8  |  |
|   |   |  | TECHNICAL FIELDS<br>SEARCHED (Int.Cl.7)      |
|   |   |  | H04Q<br>H04L                                 |
| The present search report has been drawn up for all claims  |   |  |  |
| Place of search<br><b>THE HAGUE</b>   |   | Date of completion of the search<br><b>14 January 2002</b> | Examiner<br><b>Schut, G</b>                  |
| <p><b>CATEGORY OF CITED DOCUMENTS</b></p> <p>X : particularly relevant if taken alone<br/> Y : particularly relevant if combined with another document of the same category<br/> A : technological background<br/> O : non-written disclosure<br/> P : intermediate document</p> <p>T : theory or principle underlying the invention<br/> E : earlier patent document, but published on or after the filing date<br/> D : document cited in the application<br/> L : document cited for other reasons<br/> &amp; : member of the same patent family, corresponding document</p> |   |  |  |

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**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on  
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14-01-2002

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